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AUTHOR McNamara, Kevin T.; Deaton, Brady J.
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ABSTRACT

Measures of school achievement over a 4 year lag period in Virginia's 95 school districts were used to investigate the relationship of investment in education to student achievement since variations in spending among counties would have four years to affect student achievement levels. Because educational output is a function of selected inputs--some of which can be modified by local decision makers--analysis of the production relationship of public education is of particular importance to rural communities faced with limited tax revenues. Analysis of the lagged 1974 cross-sectional achievement scores (grade four) and 1978 achievement scores (grade eight) showed that increasing local inputs for public education had a positive influence on educational output (standardized achievement test scores). The population measure was also significant, providing some support for the hypothesis that the complex community interactions available in more populous areas have a positive influence on educational production. However, using the 1974 data as both input and output measures suggested completely different conclusions; per capita income became the primary determinant of educational achievement and increasing expenditures for education would not necessarily improve school performance. Policy decisions based on research that does not incorporate the proper lag structure could provide results far different from those intended by decision makers. (BRR)

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Educational Expenditures And Education Measures

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Educational Expenditures And Education Measures

Kevin T. McNamara

and

Brady J. Deaton *

*Research Assistant, Department of Agricultural Economics, Virginia Polytechnic Institute and State University and Extension Specialist, CRD, Virginia State University; and Professor, Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061. This paper was presented at the Southern Agricultural Economics Association annual meeting, Biloxi, Mississippi, Februray, 1985.

Educational Expenditures And Human Capital Accumulation

The economic value of education has long been recognized by economists. As Adam Smith noted,

> A man educated at the expense of much labour and time... may be compared to one of those expensive machines. The work he learns to perform, it must be expected, over and above the usual wages of common labour, will replace to him the whole expense of his education, with at least the ordinary profits of an equally valuable capital...(p. 103).

Commenting on the social benefits of education Malthus reflected:

> Education appears to have a considerable effect in the prevention of crimes and the promotion of industry, morality and regular conduct (p. 496).

More recently economists have given attention to developing the theoretical framework for identifying and analyzing the economic value of education. Schultz and Becker initiated this renewed interest in the relationship of education to economics. Schultz, for example, argued that individuals invest in themselves in many ways with the expectation of future returns, and that this process amounts to capital investments. His work recognizes that education is one of the prominent processes of capital accumulation. Becker presented the theoretical framework for the analysis of human capital, concluding that human capital research would provide insight into such issues as economic development, income distribution and labor turnover. The implications of economic analysis of education for rural development were recently explored by Deaton and McNamara.

Theoretical Perspectives

Measuring Education Output

[1]

Conceptually, it is widely recognized that the education process is designed to produce multiple outputs which vary in importance by political level of the producing jurisdiction, by cultural sub-groups, and by other socio-economic characteristics (Ostrom). Economists, however, have failed to develop acceptable measures of the multiple outputs of the educational process. Consequently, their analyses have not always been useful to school jurisdictions faced with difficult allocation decisions. Of particular importance is the need to understand the relationships between student academic achievement and the mix and level of various formal and informal inputs that shape academic achievement.

The analysis that follows investigates the relationship of investment in education to student achievement as a first step toward unraveling this complex set of relationships. Three standardized achievement scores are used as measures of educational output. The analysis tests the hypothesis that local expenditures influence schooling achievement levels, using cross-sectional data from Virginia counties. Changes in the level of expenditures will not have an immediate effect on educational output. Rather, the influence can more reasonably be observed over some future time period as more effective teachers, materials and learning processes are brought into the educational system. Hence, measuring input-output relationships in education must incorporate some reasonable time dimension. There appears to have been virtually no attention given to this important issue in the economics literature. Lagged measures of school achievement will be used in this analysis to investigate whether the expenditure influence is realized over time.

While analysis of the production relationships of public education are of interest to all jurisdictions, it is of particular importance to rural communities faced with limited tax revenues, primarily from real property taxes. New federal initiatives to encourage school districts to rely on partnerships with the private sector for resources to achieve excellence in education rather than federal funds leaves rural communities with few options for increaseing educational spending other than property taxes. These communities must weigh potential benefits to the community and individuals from educational expenditures against the increased tax burden to businesses, farmers and home owners. A clear understanding of the returns to various educational outputs would clearly benefit officals faced with these decisions.

Human Capital Measures in Economics

Output measures commonly used by economists for determining private and social returns to schooling are years of schooling, total costs of education and school expenditures. Ben-Porath estimated the optimal path for human capital investment and analyzed the income implications of time allocation to education. Years of schooling was also used by Weiss and Williamson in a study which revealed that the income return for Blacks was significant. Hansen estimated the internal rates of return to both total and private resource costs for various levels of schooling from elementary school through college. Hines, Tweeten and Redfern computed social and private rates of return to investments in schooling by race, sex and region.

These studies of the returns to education used large data sets in an attempt to determine if education has a significant influence on income distribution or expected lifetime earnings, without consideration of variation in educational quality. These studies showed the returns to education to be significant for all race-sex groups through the twelfth grade.

Other areas of economic research that have included either direct or indirect theoretical links to human capital have yielded results less consistent with theoretical expectations and their policy implications have been less clear. Unstable results and/or difficulty with the interpretation of the statistical findings have brought into question the value of some economic analyses of education. This weakness was vividly illustrated in the case of Hobson v. Hansen. An economies of scale argument based on expenditure measures was used by the defense. It was rejected by the court as being inadequate primarly because "we cannot measure educational output satisfactorily or control for the influence of factors 'other than size'" (Clune, p. 279).

This problem stems from the use of expenditure measures as dependent variables in studies that use a multiple regression model to analyze determinants of public education expenditures. Although Hickrod called these demand studies, it seems more appropriate to label them expenditure analysis studies following Hirsch's critique (1977). For example, Hines, Hirsch (1960), Miner, and Welch estimated models that show per capita income, community wealth and size to be significant in

explaining the variance in expenditures for education. Conclusions from these studies regarding the amount of human capital being produced depend on the dubious assumption that school output to input cost ratios are constant across school systems. Demand studies that used household production theory have used educational expenditure measures as educational quality proxies (Barichello, Edwards, Rosenzweig).

Economy of size studies have also dealt with the quality of education issue (Fox). Cohn discussed the possibility of using an index of school inputs as a measure of quality similar to the input mix index that Welch used as a quality measure. His study, however, used an achievement test score measure as a quality proxy because it better represented the intended result of the educational process. Osburn used an expenditure value as an output measure in a study of size economies, while Riew used an accreditation rating and enrollment range to standardize quality within his observation set. In the latter two studies, strong assumptions are needed about school output-expenditure ratios being constant across school districts to make conclusions about the interpretation of the results.

State educational policies that specify standards of quality and formulate state aid to public education have generally used expenditure levels as a key target variable. The Virginia General Assembly has established a minimum per pupil expenditure level for all localities as a means of ensuring quality education. Other states have included fiscal

equity measures in their state funding formulas as a means of assuring equal quality of education throughout the state (Collins and Johnson). Clearly, the focus in state funding has been on input levels rather than on proxies that attempt to quantify educational output. This seems to imply that state legislators hope to equalize educational opportunity through the standardization of school spending.

A number of studies have also been conducted that relate economic growth to human capital. Fratoe's study of rural education and the labor force uses per pupil expenditures as an output measure. Several manufacturing location and manufacturing growth studies have used proxies for human capital. Some have used educational attainment of the adult population as a human capital stock measure (Kamer, Sulaiman and Hushak). Others have used a per pupil expenditure measure (Debertin, Pagoulatos and Smith, Smith, Deaton and Kelch; Leuck). The results of the human capital variable in these studies have been unstable and inconsistent.

A recent study of interest is Stinson's analysis of the level of poverty and educational funding. This study establishes an educational service poverty bound utilizing preference theory and a sample of median income counties. The bound is based on per pupil expenditure levels of the counties in the sample selected to estimate the bound. Here again, a strong assumption is required about the output-input ratios across counties in order to make conclusions about educational production.

Another set of studies considers educational output in a production framework. These studies (Bowles and Levin, Burkhead, Hanushek, Perl) use standardized achievement test scores as output measures, although some also used other measures such as school dropout rate and percent of students failing the selective service entrance exam. None of the studies discussed above either specified theoretically or attempted to measure a lagged relationship between changes in the level of inputs and between changes in the level of inputs and changes in schooling output.

A Model of the Determinants of School Achievement

This analysis proceeds on the assumption that educational output is a function of selected inputs, some of which can be modified by local decision makers. Problems arise in specifying measures of outputs, particularly, and inputs to some degree. The following discussion delineates our approach to these problems.

Achievement test scores are designed to measure specific skills that the school system attempts to teach students. They, therefore, are believed to provide a good measure for the intended output of a school system and are used as a measure of school output in this analysis. Virginia public schools are required to administer annually the Science Research Associates standardized achievement test (SRA) to students in grades 4, 8 and 11. The state reports one score for each test for each school district that reflects the average attainment for the

school district. These are the measures that were used in the following analysis.

Grade 8 scores were selected for the initial analysis to allow for a lag period for the dependent variable with avaliable data. The grade 8 students were the fourth grade students who took the grade 4 exam at the time the independent variables are measured. Hence, variation among counties in spending will have had four years to affect the achievement level of students. We do not know whether the cross section variation was constant over the four year period, or how important that might be. This grade was chosen over the 11th grade because eighth grade students are believed to represent a broader cross section of community socioeconomic characteristics and student abilities. That is, it is assumed that as students complete more years of schooling, attrition occurs that biases the student body toward the more successful individuals. Hence, the general model specified in this study is of the form

$$y = f(x, \ldots, x)$$

where, y = LA = the average SRA ability score
y = RA = the average SRA reading score
y = MA = the average SRA math SRA score
x = PI = per capita income
x = NLE = nonlocal per pupil educational expenditures
x = LE = local per pupil educational expenditures
x = POP = population

The output measures, the achievement test scores, are measured for grades four, eight and eleven by each school system every year. In order to incorporate a lag period, the input measures were taken from a period four years prior to the output measures. By using a four year lag period, the input data can be analysized in relation to the output four years later when the returns to the inputs are assumed to be evident in higher outputs; and, the input data can be analysized in relation to output measures for the same general group of students who would complete the forth grade SRA tests in the year the input measures are taken.

Expenditure measures represent the dollar investment in public education through school purchased inputs. Subject to school technology, increasing input quality or quantity is hypothesized to have a positive impact on education production. The expenditure measures, therefore, are hypothesized to be positively related to output of a school jurisdition as measured by SRA scores. Two expenditure measures are used in the analysis, county per pupil expenditures from local (LE) and non-local sources (NLE). The total expenditure measure for public primary and secondary education was broken into local and non-local portions to determine if the components yielded significant results as suggested in the literature (Rosenzweig). Both the local and non-local portions were then divided by the respective school district's average daily membership figure as reported by the Virginia superentendant of schools to obtain the LE and NLE variables. LE accounts for about 52%

of spending for public primary and secondary education in Virginia. Non-local expenditures are a combination of state funding, sales tax receipts and federal funds. It is hypothesized that the local expenditure level in more directly controlled by local decision making processes and that, therefore, this component of expenditures better reflects local efforts to improve education output.

Family characteristics have been recognized to influence education. Research has shown that family characteristics are significantly related to educational attainment (Conlisk) and that educational attainment is significant and postively related to income. Per capita income is, therefore, used in the model as a proxy for family characteristics since specific socioeconomic characteristics for families can not be measured very concisely from available aggregate data. A higher income allows families to spend more on educational inputs to supplement public education. In addition, higher incomes generally are positively correlated with parents' educational background as more educated parents place a greater value on their children's education. Income is, therefore, hypothesized to have a positive relationship to the test score.

Population is included in the model as a proxy for a wide range of other services and to simultaneously represent the economies of size factors in a community that affect educational production. Population seems to be an acceptable proxy for the wide range of factors that influence economies of size and in turn influence the efficiency of human capital development. For example, community services such as health

care facilities and cultural activities such as community theater and library facilities are hypothesized to have a positive influence on human capital development. A positive relationship between population and educational output is, therefore, expected.

The models were estimated using OLS with 1974 cross sectional data on Virginia's 95 counties for input measures and 1978 data for output measures. School districts are formed by county lines and function as departments of county government. The specific models estimated were:

$$LA = f(PI, NLE, LE, POP)$$

$$RA = f(PI, NLE, LE, POP)$$

$$MA = f(PI, NLE, LE, POP)$$

The output variables were test scores for eight grade students in 1978, which when used with the 1974 input measures allows for a four year lag between expenditures and testing.

Empirical Results

The estimates for the three regression models are presented in Table 1. All models were significant at the .0001 level. Two independent variables, NLE and LE, were both significant at the .01 level in the first model. Both of these expenditure variables had the hypothesized positive relationship.

The second model had three significant variables income, local expenditures, and population, PI, LE and POP. PI and LE, the income and local expenditure variables, were both significant at the .01 level.

POP, the community size measure, was significant at the 0.1 level. All three of the significant variables had the hypothisized positive relationship to RA, reading achievement.

The third model had two significant variables. LE was significant at the .01 level and POP at the .10 level. Both were positively related to MA, math achievement.

This analysis provides some insight into the relationship of achievement test scores to per pupil expenditures. The consistently significant and positive relationship of the local expenditure measure, LE, to the lagged achievement test score measures, LA, RA, and MA, supports the hypothesis that increasing local inputs for public education will have a positive influence on educational output as measured by standardized achievement test scores.

The population measure, POP, was significant and positive in the reading and math models, providing some support for the hypothesis that agglomeration, level of cultural development, or more complex interactions within the community have a positive influence on eductional production as measured by lagged achievement test scores. The results for the income and nonlocal expenditure variables, PI and NLE, were inconclusive. Each variable was significant and positive as hypothesized in one model and insignificant in the other two models.

The lag period in these models allows for increases in the quality and/or quantity of inputs to influence the educational production process and have a positive impact on output as measured by the achieve-

Table 1: Determinants of School Achievement Models with lagged school output measure.

	Model 1	Model 2	Model 3
Dependent Variable	LA	RA	MA
INTERCEP	19.7118	1.376	1.589
	(3.479)	(2.982)	(3.190)
PI	0.00001	.00002	.000021
	(.00002)	(.00001) **	(.000013)
NLE	0.1689	.0489	.0239
	(.0564) *	(.0449)	(.0480)
LE	0.6693	.7674	.7810
	(.0864) *	(.0687) *	(.0735) *
POP	.0281	.0443	.0435
	(.0278)	(.0221) **	(.0236) **
R sq.	.4920	.7015	.6822

Standard errors are in parentheses; * = significant at the 0.01 level
** = significant at the 0.10 level

n = 94 for all models; LA = SRA learning ability achievement test score of eight grade students
RA = SRA reading ability achievement test score of eight grade students
MA = SRA math ability achievement test score of eight grade students
PI = per capita income
NLE = per pupil nonlocal educational expenditur
LE = per pupil local educational expenditures
POP = population

Dependent variables from 1974.
Independent variables from 1978.

ment scores. A four year lag period was selected because of available data and that achievement test are administered annually for students in grades 4, 8 an 11. Further investigation is needed to determine the optimal period for measuring the lag structure of returns to increases in local expenditure expenditures.

Review of the coefficients of the models estimated without lagging the dependent variable illustrate the significance of the above results. A second set of models is presented in Table 2. These models used the same 1974 data for the independent variables, or educational production input measures, as in the above models. The output measures, the achievement test scores, however, are also taken from the same year, 1974, rather than lagged as in the earlier models.

The significance and the signs of variables are greatly altered in the second set of models. Model 1, the learning ability model, has all four input measures significant. Income and population, PI and POP, are positive as hypothesized, while both of the expenditure measures, LE and NLE, are negative. This negative or inverse relationship does not support the hypothesis that increased spending will improve educational achievement as measured by the standardized achievement test scores. The results for the reading and math models are similar. Both of the expenditure measures in the models are negative and are significant in three of the four cases. The income measure PI, is positive and significant in both models, while the population measure is significant in neither.

Table 2: Determinants of School Achievement Models. without lagged school output measures

	Model 1	Model 2	Model 3
Dependent Variable	LA	RA	MA
INTERCEP	33.9156 (7.1442)	46.8627 (8.3148)	36.6021 (9.7653)
PI	0.0049 (.0009) *	.0050 (.0011) *	.0042 (.00125) *
NLE	-0.0132 (.0071) **	-.0266 (.0083) *	-.0131 (.00973)
LE	-0.0123 (.0044) *	-.0143 (.0051) *	-.0117 (.0060) **
POP	.00003 (.00001) *	.00002 (.00001)	.00003 (.00002)
R sq.	.5205	.4924	.3052

Standard errors are in parentheses; * = significant at the 0.01 level
** = significant at the 0.10 level

n = 94 for all models; LA = SRA learning ability achievement test score of fourth grade students
RA = SRA reading ability achievement test score of fourth grade students
MA = SRA math ability achievement test score of fourth grade students
PI = per capita income
NLE = per pupil nonlocal educational expenditur
LE = per pupil local educational expenditures
POP = population

Both independent and dependent variables measured in 1974.

The results of this second set of models suggests completely different conclusions from the set with the lagged output measures. This second set appears to indicate that per capita income is the primary determinant of educational achievement and that increasing expenditures for education will not necessarily improve school performance. In other words, these models suggest school outcomes are determined by socioeconomic factors and school inputs into the educational process are of limited benefit. While consistent with the controversial Coleman Report, the more logically consistent models, whose results are reported in Table 1, reveals that local expenditures do count a great deal. The results in Table 2 might reflect local attempts to improve school performance as measured by achievement scores with increased local educational investment.

Conclusions

The analysis of these two sets of models, one with dependent and independent variables from the same year and the other with the dependent variable specified for a time period four years later, reveals the importance of examining outcomes in a model with lagged variables. Policy decisions based on research that does not incorporate the proper lag structure could provide results far different from those intended by the decision makers. We suspect that this weakness in analytical design has produced confusing results that have misled policy makers to a large degree.

Discussion of prior research that uses education expenditure measures illustrates the interpretation problems that arise without a clear understanding of the input-output relationships of the education production function. Interpretation of the returns to education investments and the expenditure analysis studies are straight forward. Expenditure measures in these studies are used as investment or cost measures and are not tied directly to educational output measures. The present research raises questions about the interpretation of studies that have directly related expenditures on education to educational output.

Education production studies have used both expenditure measures and specific input measures as inputs in cross sectional models without giving consideration to the dynamic nature of human capital and the need for lags to be incorporated into output measures. The studies that used expenditure measures as input measures are difficult to interpret in light of the above results. Most of the production studies, however, used measures for specific school inputs rather than expenditure amounts. These studies also included no output lags. Further research is needed to determine if a lagged output structure should be incorporated into this type of study.

The location studies mentioned above that used expenditure measures now can be more clearly interpreted given this understanding of the lagged effect of educational expenditures. The expenditure measures represent local investment in education that will have future im-

pacts on the level of human capital in the community and the future quality of labor available in the work force, rather than measures for currently existing human capital. Hence, as a determinant of industrial location, expenditure levels may be reasonable for a farsighted industry.

Community leaders making decisions about educational expenditure levels must recognize the long term nature of human capital investments and that strategies to improve the quality of local education likely will require a lag period before returns in the level of human capital as measured by standardized achievement test scores will be realized in the community. Researchers, also, must realize the lagged nature of the relationship between education production inputs and changes in outputs. Further research is needed to examine this lag structure and provide decision makers with insight into the relationship of current education investments on future human capital availability, changes in local income, and local economic development potential. Understanding these issues is essential to sound local policies to allocate resources to achieve community goals.

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